Mount Rainier National Park
Science Brief

National Park Service
U.S. Department of the Interior

Mount Rainier National Park

Forecasting the Future of Pacific Northwestern Forests

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Importance

Old growth forests in western Washington, including those in Mt. Rainier National Park, provide important ecosystem services (resources and functions of value to humans). Specifically, forests house endangered species (e.g. the Northern Spotted Owl), sequester carbon (thus mitigating the negative impacts of fossil fuel consumption), and stabilize water supply (e.g. the Nisqually River, which has its headwaters in Mount Rainier National Park, provides Tacoma with hydropower through the Alder Lake Dam). Also, old growth forests provide aesthetic and spiritual pleasure to both local and international visitors to Mount Rainier National Park.

Status and Trend

Forests in Mt. Rainier National Park are threatened by climate change. Temperatures have already increased by ~ 0.75 °C in the last century, and are expected to continue rising as humans continue to increase greenhouse gases (an additional 2-4°C warming is predicted in the next 100 years - Mote & Salathé 2009). Rising temperatures are likely to affect other climatic parameters, including snowpack (declining), date of snow meltout (earlier), severe frost events (fewer) and summer droughts (increasing). These changes will undoubtedly influence forests in Mt. Rainier National Park. For example, spring will come earlier, increasing the length of the growing season. As it gets warmer and less snowy, trees may also be able to colonize meadows above treeline, shifting the distribution of forest upslope. Late summer droughts, however, may also negatively impact forests by increasing tree mortality and lowering seedling recruitment of moisture-loving trees, like western red cedar (*Thuja plicata*). In total, the distribution of forest trees in Mount Rainier National park is predicted to shift upwards (Figure 1).

Discussion

Great uncertainties exist in our understanding of how different tree species will respond to climate change. For example, tree species are likely to differ in their sensitivity to climatic parameters (e.g. length of the growing season vs. frost events), which means that the composition of forests may change as trees that benefit from climate change (‘winners’) displace those that don’t (‘losers’). But, if tree species differ in their ability to colonize habitats rendered suitable by warming OR the rate at which they disappear from habitats made unsuitable by warming, these long-term changes to forest composition may take decades to emerge.

Research by the HilleRisLambers lab at Mount Rainier National Park (Biology Department, University of Washington) examines these issues by linking tree performance (e.g. tree growth, seed production, seedling germination – Figure 2) to microclimate variability (e.g. snow duration, temperature – Figure 3), and using these results to develop models that can help us project future changes to forest composition and species distributions. Thus far, our research demonstrates that tree species differ in their sensitivity to climatic parameters (implying that forest composition will change in response to climate change).

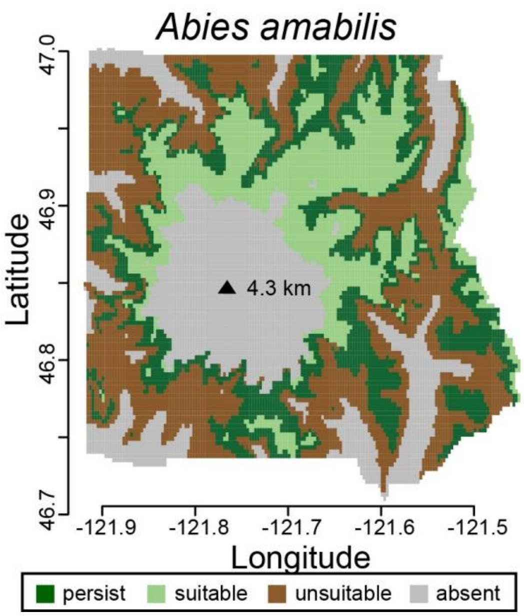

Figure 1. Potential changes to the distribution of Pacific silver fir (*Abies amabilis*) in Mount Rainier National Park with 2°C warming. Dark green areas marks where 'climate envelope' models predict Pacific Silver fir will persist with 2°C warming (the magnitude of warming projected for the Pacific Northwest by 2040). Dark brown marks areas where the species occurs now, but may not with future warming. Light green marks parts of the park where climate change may render suitable for Pacific Silver fir by 2040. Grey marks areas of the park where the species is currently absent, and predicted to remain absent. Whether or not the distribution of Pacific Silver fir will actually shift by occupying light green areas and disappearing from brown areas depends on its' ability to colonize newly suitable habitat (light green) and the rate at which adult trees will dies in unsuitable habitats (dark brown).

Figure 2. Undergraduate field assistants Mitch Piper and Anna O'Brien quantify seedling germination in a meter squared plot (marked by white pvc pipes). The laundry basket next to Mitch Piper is a seed trap (which allows us to measure seed production). A small microclimate sensor is visible right on the forest floor in front of Anna O'Brien, this sensor monitors hourly temperature and allows us to identify when snow disappears from our seedling quadrat. Photo courtesy of Erin Curtis.

Figure 3. Graduate student Ailene Ettinger and undergraduate field assistant Jonathan Deschamps install a temperature sensor in one of the eighteen forest stands in which the HilleRisLambers lab monitors tree performance and microclimate. Temperature sensors need to be suspended from tree branches at least 20 feet above the forest floor, so they do not get covered by snow, which would prevent accurate measurements of air temperature.